What Is Claimed Is:

1. A device for frequency down-converting a photonic signal incident upon the device, comprising:

a plurality of first material layers; and

a plurality of second material layers,

the first and second material layers being adapted to receive first and second photonic signals incident upon the device and having respective first and second frequencies, the first and second material layers being arranged such that the device exhibits a photonic band gap structure, wherein the photonic band gap structure exhibits first and second transmission band edges respectively corresponding to the first and second frequencies, and wherein an interaction of the first and second photonic signals with the arrangement of layers causes a mixing process to generate a third photonic signal having a third frequency that is less than the first and second frequencies.

2. The device of claim 1, wherein said first and second material layers are arranged in a periodically alternating manner such that the arrangement formed therefrom exhibits said photonic band gap structure.

3. The device of claim 1, wherein said first material layer has a first index of refraction and said second material layer has a second index of refraction, said first index of refraction and said second index of refraction being different.

4. The device of claim 1, wherein said first material layer has a first thickness and said second material layer has a second thickness, said first thickness and said second thickness being different.

5. The device of claim 1, wherein said photonic band gap structure also exhibits a set of transmission resonances near the third order band gap, and wherein said third frequency is tuned such that phase matching conditions are satisfied to enhance the generation of the third frequency.

6. The device of claim 1, wherein each of said first and second input photonic signals is one of 1) a continuous wave photonic signal generated by a continuous wave laser source, and 2) a pulsed photonic signal generated by a pulsed laser source.

7. The device of claim 1, wherein said arrangement of layers forms a mixed half-eighth wave multilayer stack, and said second frequency is 2ω, and the input photonic signal frequency has frequency 3ω.

8. The device of claim 1, wherein said arrangement of layers forms a mixed half-eighth wave structure.

9. The device according to claim 1, wherein said first and second material layers respectively comprise GaAs and AlAs semiconductor layers, said first and second layers being formed on an appropriate substrate.

10. The device according to claim 1, wherein said first and second material layers respectively comprise AlN and SiO_2 layers, said first and second layers being formed on a appropriate substrate.

11. The device of claim 1, wherein a length of the device is between a few hundred nanometers and a few thousand microns.

12. A method of frequency down-converting a photonic signal incident on a device, the device including a plurality of first material layers and

a plurality of second material layers, the first and second material layers being arranged such that the device exhibits a photonic band gap structure, wherein the photonic band gap structure exhibits first and second transmission band edges, the method comprising the steps of:

applying first and second photonic signals to the first and second material layers, the first and second photonic signals having respective first and second frequencies corresponding to the first and second transmission band edges, wherein an interaction of the first and second photonic signals with the arrangement of layers causes a mixing process to generate a third photonic signal having a third frequency that is less than the first and second frequencies.

13. The method of claim 12, further comprising the step of mixing the first and second frequencies such that the third frequency is the difference between the first and second frequencies.

14. The method of claim 12, wherein the mixing step generates the third frequency such that the third frequency is tuned to a third transmission resonance associated with a third band gap edge.

15. The method of claim 12, wherein a number of input beams may be injected to a plurality of first and second layers, such that phase matching conditions are satisfied.

16. A device for frequency up -converting a photonic signal incident upon the device, comprising:

a plurality of first material layers; and

a plurality of second material layers,

the first and second material layers being adapted to receive a first photonic signal incident upon the device and having a first frequency, the first and second material layers being arranged such that the device exhibits a photonic

band gap structure, wherein the photonic band gap structure exhibits first and second transmission band edges respectively corresponding to the first and second frequencies, and wherein an interaction of the first photonic signal may generate a second photonic signal with a frequency near the second band edge, and such that the arrangement of layers causes a further mixing process to generate a third photonic signal having a third frequency that is more than the first and second frequencies.

17. The device of claim 16, wherein said first and second material layers are arranged in a periodically alternating manner such that the arrangement formed therefrom exhibits said photonic band gap structure.

18. The device of claim 16, wherein said first material layer has a first index of refraction and said second material layer has a second index of refraction, said first index of refraction and said second index of refraction being different from one another.

19. The device of claim 16, wherein said first material layer has a first thickness and said second material layer has a second thickness, said first thickness and said second thickness being different from one another.

20. The device of claim 16, wherein said photonic band gap structure also exhibits a third transmission resonance at a third order band gap, and wherein said third frequency is tuned to said third transmission resonance.

21. The device of claim 16, wherein the input photonic signal is one of 1) a continuous wave photonic signal generated by a continuous wave laser source, and 2) a pulsed photonic signal generated by a pulsed laser source.

22. The device of claim 16, wherein said arrangement of layers forms a mixed half-eighth wave multilayer stack, and said second frequency is a second harmonic of the input photonic signal frequency, and said third photonic signal is a third harmonic of the input photonic signal frequency.

23. A method of frequency up-converting a photonic signal incident on a device, the device including a plurality of first material layers and a plurality of second material layers, the first and second material layers being arranged such that the device exhibits a photonic band gap structure, wherein the photonic band gap structure exhibits first and second transmission band edges, the method comprising the steps of:

applying a first photonic signal to the first and second material layers, generating a second photonic signals having a second frequency corresponding to the second transmission band edge, wherein a subsequent interaction of the first and second photonic signals with the arrangement of layers causes a mixing process to generate a third photonic signal having a third frequency that is more than the first and second frequencies.

24. The method of claim 23, wherein a first and second photonic signal are injected inside the plurality of layers.

25. The method of claim 23, further comprising the step of mixing the first and second frequencies such that the third frequency is the sum of the first and second frequencies.

26. The method of claim 23, wherein the mixing step generates the third frequency such that the third frequency is tuned to a third transmission resonance associated with a third band gap edge.

27. The method of claim 23, wherein a number of input beams may be injected to a plurality of first and second layers, such that phase matching conditions are satisfied.